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SITE-SPECIFIC WORK PLAN FOR THE AIR FORCE ENVIRONMENTAL DIRECTORATE PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION AT BUCKLEY AFB

July 2001

Prepared for:

Air Force Center for Environmental Excellence
Technology Transfer Division

And

Air Force Environmental Directorate

CONTRACT NO. F41624-00-8024
Task Order No. 0024

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LIST OF ACRONYMS AND ABBREVIATIONS

AFILEV	Air Force Environmental Directorate
AFB	Air Force base
AFCEE	Air Force Center for Environmental Excellence
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
ANOVA	Analysis of variance
cis-1,2-DCE	Cis-1,2-dichloroethene
COPC	Chemical o potential concern
DCA	Dichloroethane
DOD	Department of Defense
DOT	Department of Transportation
ERM	Environmental Resources Management
FDA	Former Depot Area
FMP	Former Air Force Motor Pool Area
ft/ft	Feet per foot
FWA	Former Warehouse Area
GIS	Geographical information system
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
LTM	Long-term monitoring
Parsons ES	Parsons Engineering Science, Inc.
PCE	Tetrachloroethene
PDBS	Passive diffusion bag sampler
PPE	Personnel Protective Equipment
PSG	Project Screening Goal
RI	Remedial Investigation
RPD	Relative percent difference
SAP	Sampling and Analysis Plan
SI	Site Investigation
SVOC	Semivolatile organic compound
TCE	Trichloroethene
TEH	Total extractable hydrocarbons
TO	Task order
TVH	Total volatile hydrocarbons
URS	URS Corporation
USCWTP	Upper Sand Creek Wastewater Treatment Plant
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound

1.0 INTRODUCTION

1.1 Project Description

On 27 February 2001, Parsons Engineering Science, Inc. (Parsons ES) was awarded a task order (TO) under Air Force Center for Environmental Excellence (AFCEE) contract F41624-00-D-8024 (TO24, Project Air Force Environmental Directorate [AFILEV]) to demonstrate the use of passive diffusion bag samplers (PDBSs) in existing groundwater monitoring programs at selected AFILEV installations. The site of the PDBS demonstration outlined in this work plan is Buckley Air Force Base (AFB), Colorado. The Technology Transfer Division of AFCEE (AFCEE/ERT) has initiated the PDBS demonstration to introduce this technology to multiple Department of Defense (DOD) installations and to improve the cost effectiveness of groundwater monitoring programs for volatile organic compounds (VOCs).

Diffusion sampling is a relatively new technology designed to utilize passive sampling techniques that eliminate the need for well purging. Specifically, a diffusive-membrane capsule is filled with deionized/distilled water, sealed, suspended in a well-installation device, and lowered to a specified depth below the water level in a monitoring well. Over time (no less than 72 hours), the VOCs in the groundwater diffuse across the membrane, and the water inside the sampler reaches equilibrium with groundwater in the surrounding formation. The sampler is subsequently removed from the well, and the water in the diffusion sampler is transferred to a sample container and submitted for laboratory analysis of VOCs. Benefits of diffusion sampling include reduced sampling costs and reduced generation of investigation-derived waste.

1.2 Objective

The PDBS demonstration at Buckley AFB has two primary objectives:

- Develop vertical profiles of VOC concentrations across the screened intervals of the sampled monitoring wells, and

- Assess the effectiveness of PDBS by statistically comparing groundwater analytical results for VOCs obtained using the current (conventional) sampling method (i.e., 3-casing-volume purge/sample) with results obtained using the PDBS method.

Vertical contaminant profiles will be developed by placing multiple PDBSs at discrete screened depths in each monitoring well included in the demonstration, and analyzing the resulting samples for VOCs. The resulting information will aid the Base in evaluating contaminant migration and fate in the saturated zone, and will allow optimization of the long-term monitoring (LTM) through collection of future groundwater samples from the depth interval of greatest contaminant concentrations. The statistical comparison of the conventional and diffusion sampling results will allow assessment of the appropriateness of implementing diffusion sampling for VOCs at each sampled well.

1.3 Scope

The Buckley AFB PDBS demonstration will require two mobilizations to the site: one to place the diffusion samplers in the selected monitoring wells, and a second to retrieve the samplers from the wells. The PDBSs will be installed during the last week in July 2001 to provide adequate equilibration time before the current environmental contractor for Buckley AFB, URS Corporation (URS), begins the scheduled pilot testing and groundwater sampling event scheduled to begin later in August, 2001. The PDBSs will be retrieved immediately prior to the conventional sampling event to ensure temporal comparability of the analytical results obtained using the two methods. The PDBSs will be in place for a minimum of 14 days, which fulfills the 14-day minimum equilibration time period specified in the AFILEV PDBS Project Work Plan (Parsons ES, 2001).

1.4 Document Organization

This work plan is organized into seven sections, including this introduction, and three appendices. The Buckley AFB site description is presented in Section 2. Section 3 presents the scope of the PDBS investigation at Buckley AFB. Project organization, schedule, and an overview of the PDBS site-specific results report are summarized in Sections 4, 5, and 6, respectively. References used in the preparation of this work plan are presented in Section 7. Appendix A provides a site-specific addenda to the Project Health and Safety Plan (HASP) (Parsons ES, 2001). Appendix B contains the ERM sampling and analysis plan (SAP) for conventional groundwater sampling. Appendix C contains documentation for the field test kits to be used for this project.

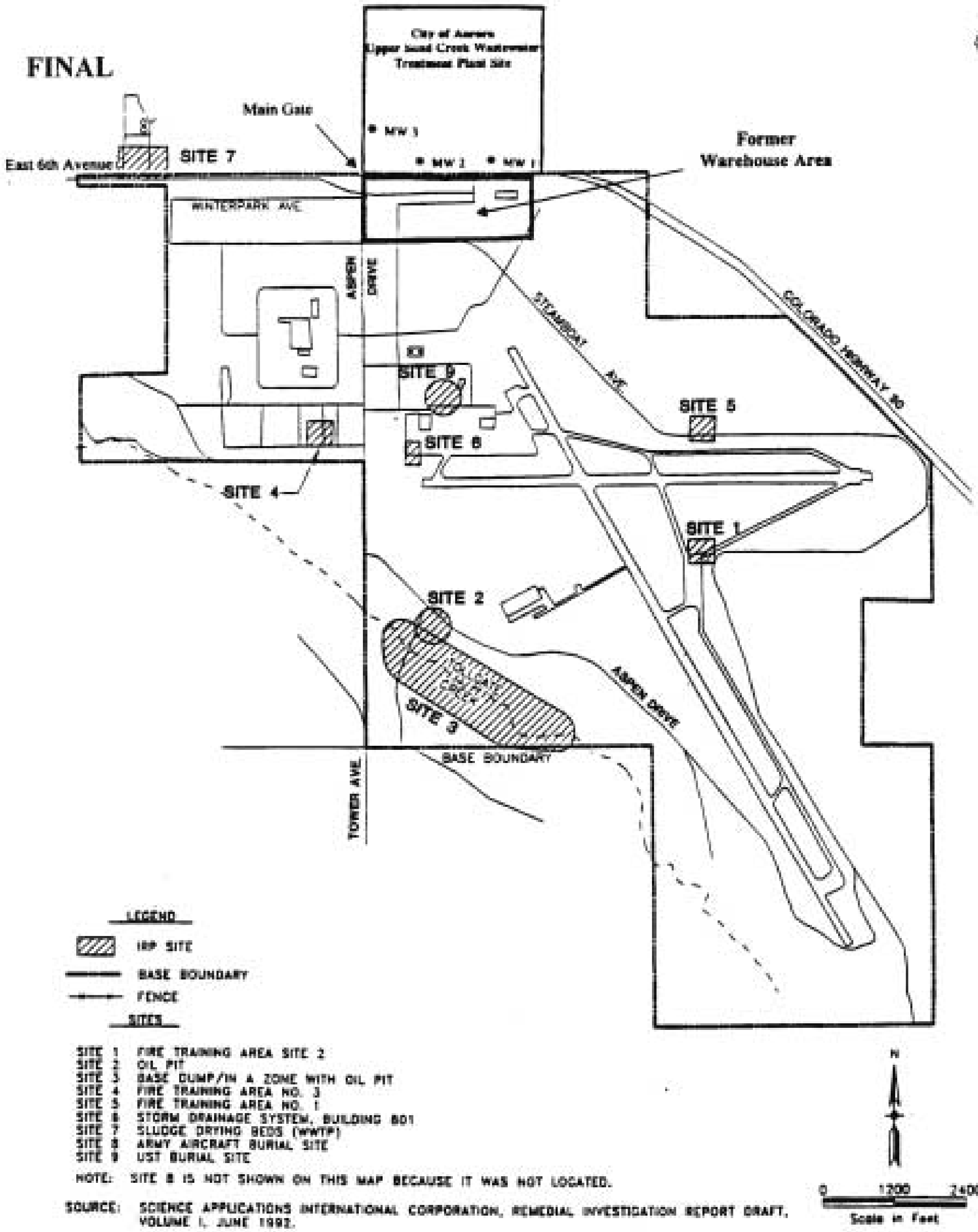
2.0 SITE DESCRIPTION

2.1 Location and Description of Buckley Air Force Base Colorado

Buckley AFB is located in Arapahoe County, north-central Colorado, approximately 5 miles east of Denver, Colorado. The Base occupies approximately 3,328 acres (Figure 2.1)

Buckley AFB has been an active air Base since the early 1940s. The U.S. Army Air Corps of Engineers operated the Base from 1942 to 1946 when the Base was deactivated. In 1946, ownership was transferred to the State of Colorado, and the Base was occupied by the Colorado Air National Guard. In 1947 the U.S. Navy assumed control of a portion of the Base for use as a training area. In 1959 the U.S. Navy deactivated the station and transferred the property back to the Colorado Air National Guard. The Base has stored and used various types of fuels and other chemicals during its history in support of its primary missions of combat training, transient aircraft support, and search and rescue response.

Installation Restoration Program (IRP) Site 10, also known as the Former Warehouse Area (FWA) is located near the northern boundary of Buckley AFB, as shown on Figure 2.1. The FWA is divided into four areas:



Source: Stone & Webster, (SI Report), 1977.

FIGURE 2.1

SITE LOCATION RELATIVE TO BUCKLEY AFB

Passive Diffusion Bag Sampler Demonstration
Buckley AFB, Colorado

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The Former Depot Area (FDA);

- The Former Air Force Motor Pool Area (FMP);
- The Former Naval Civil Engineering Utility Yard; and
- The Former Naval Barracks/Stockade.

Based on a site investigation (SI) conducted in 1996 (Stone and Webster, 1997), the soil and groundwater within the FWA had been impacted with VOCs (primarily tetrachloroethene [PCE]) and petroleum hydrocarbons. The SI also indicated that surface spills associated with historical activities at former Warehouse 505 appeared to be the primary source of those contaminants to the soil and groundwater.

Due to the migration of contaminants originating at the FDA, the PDBS demonstration will be extended onto the City of Aurora property formerly proposed for the Upper Sand Creek Wastewater Treatment Plant (USCWTP) (Figure 2.1). Special access permission will not be required to access the wells on City of Aurora property. However, Jim Ives with the the City of Aurora will be notified a minimum of one week prior to the installation of the PDBSs in wells located on City of Aurora property.

2.2 Environmental Setting

2.2.1 Geology

The geology of the FWA and USCWTP area consists of unconsolidated eolian deposits overlying the irregular, erosional surface of the Denver Formation (Environmental Resources Management [ERM], 2000). The eolian deposits consist primarily of mixtures of silt and clay, with occasional lenses of silty clay at the base of the deposits. Within the FWA and the USCWTP area, eolian deposits range in thickness from 2 to 29 feet.

The Denver formation beneath the FWA and USCWTP property is very nonhomogeneous, composed primarily of fractured to unfractured, hard, claystones and siltstones with interbedded and interfingered layers and lenses of silty fine- to coarse-grained sandstone ranging in thickness from a few inches to several feet. The lithologic composition of the Denver Formation reflects its depositional environment of low-energy meandering streams and widespread overbank deposits. While most of the sandstone layers were relatively thin (less than 3 feet thick) and apparently discontinuous, a relatively thick (13 to 19 feet) sandstone layer was encountered in several well borings in the northwest portion of the USCWTP property. Based on the similar lithology, elevation, and thickness, this thick sandstone layer has been interpreted as a paleochannel within the Denver Formation. Although several other sandstone layers appear to be correlative based on elevation, limited data (generally widely-spaced wells) prevents positive correlation between these layers.

2.2.2 Hydrogeology

Shallow groundwater beneath the FWA and USCWTP property is encountered primarily within the coarse-grained materials (sand and sandstone). Although groundwater may also exist within fractured portions of the fine-grained materials (silty clay, claystones and siltstones), the absence of groundwater in several wells screened in the fine-grained materials indicates that groundwater is not generally present within those materials.

Groundwater in sand and sandstone above an elevation of approximately 5,470 feet above mean sea level (amsl) occurs generally under unconfined conditions, while groundwater in deeper rocks exists under confined to semi-confined conditions. The unconfined aquifer is interpreted to be associated with the upper, weathered and fractured portion of the Denver formation. Because of the irregular weathering of the Denver Formation, the lower extent of the unconfined groundwater system is also variable. Based on November 2000 water level data (ERM, 2001), the shallow, unconfined groundwater beneath the FWA and USCWTP property flows generally toward the north except for an area beneath the eastern portion of the USCWTP property, where the groundwater flow is toward the west. The local westerly flow direction appears to be the result of groundwater flowing around a localized barrier of impermeable, unsaturated Denver Formation. In November 2000, the hydraulic gradient of the unconfined groundwater was between about 0.01 and 0.04 feet per foot (ft/ft).

Groundwater in Denver Formation sandstones at elevations below approximately 5,470 feet amsl exists under confined to semi-confined conditions. As described in Section 2.2.1, there is a reasonable correlation between several sandstone layers. These correlations, along with the relatively uniform potiometric surface of the confined groundwater, indicates that many of these sandstone layers are physically and hydraulically connected. Potiometric surface contours indicate that the confined groundwater flows toward the northeast with a hydraulic gradient of approximately 0.02 ft/ft. Data from slug testing performed in the former warehouse area during the RI indicates that hydraulic conductivities in the former warehouse area range from $4x10^{-4}$ to $1x10^{-6}$ ft/sec (ERM, 1999b).

2.3 Chemicals of Concern

Chemicals of primary concern (COPCs) identified in the groundwater beneath the FWA, FDA, and USCWTP include trichloroethene (TCE), PCE, cis-1,2-dichloroethene (cis-1,2-DCE), dichloroethane (DCA), carbon tetrachloride, bromodichloromethane, bromoform, dibromochloromethane, methylene chloride, chloroform, total extractable hydrocarbons (TEH), and total volatile hydrocarbons (TVH) (ERM, 2001). COPCs were identified as those constituents detected at concentrations exceeding project screening goals (PSGs). Some metals and semivolatile organic compounds (SVOCs) also are present in groundwater in these areas. Of these COPCs, PCE was the only VOC consistently detected in most samples at concentrations exceeding its PSG.

2.4 Current Groundwater Monitoring Program

A formal groundwater monitoring program has not been established for the FWA and USCWTP properties because of the ongoing site characterization and feasibility testing activities. Groundwater sampling was performed as part of the SI (Stone & Webster, 1997), Remedial Investigation (RI) (ERM, 2000), and subsequent additional plume characterization activities (ERM, 2001a), conducted in 1996, 1998, and 2000-2001, respectively. Additional monitoring wells are proposed to be installed and sampled to further characterize the lateral and vertical extent of VOCs and as part of a feasibility study for groundwater remediation planned for 2001.

3.0 SCOPE OF PDBS DEMONSTRATION

An estimated total of 28 passive diffusion samplers will be installed in 16 monitoring wells at Buckley AFB as part of this project. An additional 4 alternate monitoring wells have been designated for sampling in the event that one or more of the primary monitoring wells cannot be sampled. Dedicated pumps are not presently installed in any of the candidate monitoring wells. All 16 of the primary monitoring wells to be sampled are screened in the shallow aquifer, and the 4 alternate wells are screened in the deeper, confined aquifer. The monitoring wells that will be sampled during this PDBS demonstration are summarized on Table 3.1, and their locations are shown on Figure 2.2. Because only 4 of the primary wells are proposed to be sampled by ERM, the remaining 12 primary wells will be sampled for VOCs by Parsons ES using both conventional and PDBS sampling techniques. Conventional groundwater sampling will be performed in accordance with procedures specified in the URS groundwater SAP (Appendix B).

3.1.1 Field Activities

Monitoring wells selected for VOC sampling using the PDBS technique (Table 3.1) were chosen from the list of monitoring wells previously sampled by ERM. Monitoring wells were selected based primarily on VOC concentrations detected during previous sampling events, as indicated below. Selected wells include:

- 15 wells at which concentrations of PCE exceeded the PSG during 2000; and
- One upgradient well at which VOCs have not been detected.

PDBSs deployed during this investigation will be installed and retrieved in general accordance with the diffusion sampler installation and recovery standard operating procedures presented in Appendix B of the AFILEV PDBS Project Work Plan (Parsons ES, 2001). PDBSs will be installed throughout the screened interval of each well (i.e., 1 PDBS per 3 feet of saturated screen) to obtain a vertical profile of contaminant concentrations. The PDBS samples will be collected, and conventional sampling performed prior to the 2001 URS pilot test. Analysis of the vertical profiling samples is discussed in Section 3.1.2.

Sample aliquots from PDBSs and samples collected using conventional techniques will be shipped to O'Brien and Gere Laboratory, Inc. for VOC analysis using US Environmental Protection Agency (USEPA) Method 8260B. This is the same laboratory that will be used by URS during their conventional sampling of the same wells. Field quality control samples will be collected at the following frequencies:

- 10 percent field duplicates;

TABLE 3.1
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
BUCKLEY AFB, COLORADO

Well Number	Primary/Alternate (P/A)	Sampling Method	Total Depth (ft)[a]	Well Diameter (in)[b]	Screened Interval (ft Below TOC)[c]	Dominant Lithology of Screened Interval	Approximate Water Level Range (ft below TOC)	Average Depth to Water	Average Saturated Screen Length	Aquifer Unit	Estimated Number of PDBSs	Main COC and Feb. 2000 Contaminant Concentration (mg/L)[d]	Comments/Sampling Rationale
Sites: FWA & USCWTP													
FWA-MW4	P	PDBS & C[e]	39.0	2	14-24	Clay	16.3 - 20.2	18.3	6.00	Unconfined	2	PCE: 23	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW11	P	PDBS	32.0	2	22-32	Sand & sandstone	23.4 - 27.6	25.5	6.50	Unconfined	2	PCE: 1,110	PCE exceeds PSG: High PCE concentration.
FDA-MW11A	P	PDBS	29.5	2	14-29	Clay & weathered claystone	22	22	7.00	Unconfined	2	PCE: 9,350	PCE exceeds PSG: High PCE concentration.
FDA-MW11B	P	PDBS	36.5	2	14.5-29.5	Silty clay & weathered claystone	22	22	7.00	Unconfined	2	PCE: 4,100	PCE exceeds PSG[f]: High PCE concentration.
FDA-MW11C	P	PDBS	35.0	2	14-29	Silty clay & weathered claystone	22	22	7.00	Unconfined	2	PCE: 3,580	PCE exceeds PSG: High PCE concentration.
FDA-MW15	p	PDBS & C	30.0	2	13-28	Claystone	21.0 - 22.0	21.5	6.50	Unconfined	2	PCE: 122	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW16	P	PDBS & C	24.0	2	9-24	Claystone	17.4 - 20.9	19.2	5.00	Unconfined	1	PCE: 3,240	PCE exceeds PSG: High PCE concentration.
FDA-MW17	P	PDBS & C	35.0	2	15-25	Clay & weathered claystone	19.6 - 26.1	22.9	2.00	Unconfined	1	PCE: 25.9	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW25	P	PDBS & C	35.0	2	25-35	Competent to weathered sandstone	27.0 - 27.8	27.4	7.60	Unconfined	2	PCE: 5.47	PCE exceeds PSG: Low PCE concentration.
FDA-MW26	P	PDBS & C	37.5	2	22.5-37.5	Competent to weathered sandstone	26.7 - 27.4	27.1	10.00	Unconfined	3	PCE: 3.32	PCE exceeds PSG: Low PCE concentration.
FDA-MW27	P	PDBS & C	32.0	2	22-32	Weathered sandstone	25.1 - 25.7	25.4	6.60	Unconfined	2	PCE: 5.21	PCE exceeds PSG: Low PCE concentration.
FDA-MW28	P	PDBS & C	30.0	2	20-30	Weathered siltstone and sandstone	26.3 - 26.9	26.6	3.40	Unconfined	1	PCE: 65.2	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW36	P	PDBS & C	31.0	2	21-31	Weathered sandstone	36.0 -	28.0	3.00	Unconfined	1	PCE: 20.5	PCE exceeds PSG: Moderate PCE concentration.
FWA-PZ4	P	PDBS & C	54.0	2	44-54	Clay & silty clay	31.7 - 36.4	34.1	10.00	Unconfined	3	PCE: ND[g]	Upgradient Well: No analytes detected.
FWA-PZ5	P	PDBS & C	24.0	2	13-23	Sandy clay to clayey sasnd	18.4 - 21.3	19.9	3.10	Unconfined	1	PCE: 312	PCE exceeds PSG: High PCE concentration.
FWA-PZ6	P	PDBS & C	39.0	2	13-23	Clay	18.0 - 21.5	19.8	3.20	Unconfined	1	PCE: 9.39	PCE exceeds PSG: Low PCE concentration.
FDA-MW22	A	PDBS & C	54.0	2	44-54	Sandstone	38.6 - 39.5	39.1	10.00	Confined	3	PCE: 22.3	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW32	A	PDBS & C	34.0	2	24-34	Weathered sandstone to silty sandstone	28.8	28.8	5.20	Confined	1	PCE: 19.3	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW34	A	PDBS & C	70.0	2	65-70	Sandstone	42.3	42.3	5.00	Confined	1	PCE: 12.4	PCE exceeds PSG: Moderate PCE concentration.
FDA-MW35	A	PDBS & C	65.0	2	52-62	Weathered sandstone	41.1	41.1	10.00	Confined	3	PCE: 88.2	PCE exceeds PSG: Moderate PCE concentration.

Notes:
PCE = Tetrachloroethene
[a] ft = feet; in = inches.
[b] in = inches.
[c] TOC = top of casing.
[d] μg/L = micrograms per liter.
[e] PDBS = Passive diffusion bag sampling; C = Conventional sampling.
[f] PSG = Preliminary screening goal.
[g] ND = not detected.

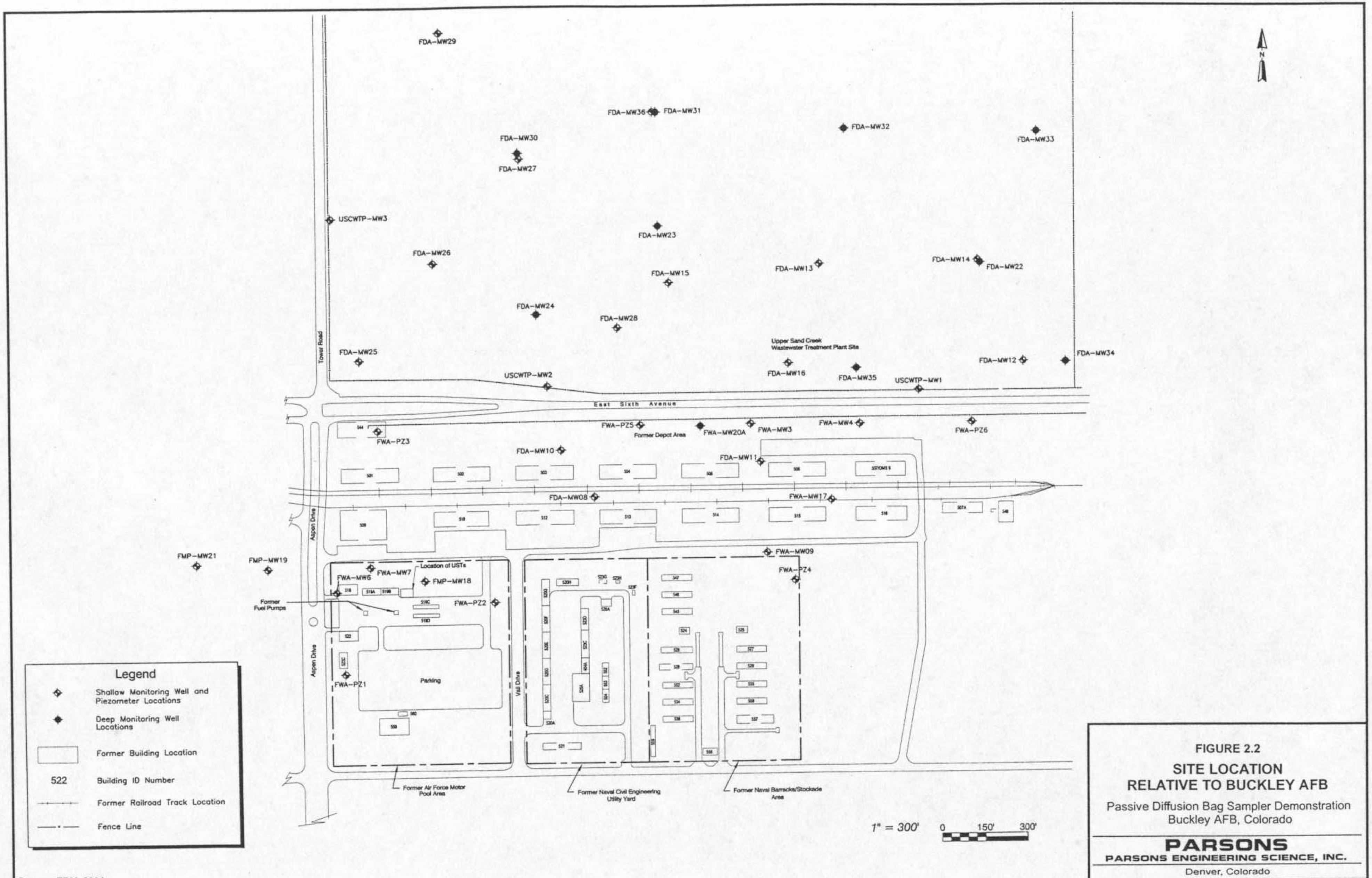

FIGURE 2.2

SITE LOCATION RELATIVE TO BUCKLEY AFB

Passive Diffusion Bag Sampler Demonstration
Buckley AFB, Colorado

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- 5 percent matrix spikes and matrix spike duplicates;
- 1 pre-installation equipment rinsate blank;
- 1 pre-installation source water blank;
- 1 conventional sampling equipment rinsate blank; and
- Approximately 3 trip blanks.

3.1.2 Contaminant Profiling and Field Screening

Per the project work plan (Parsons ES, 2001), contaminant profiling within the screened intervals of the LTM wells will be conducted using field-screening methods, with only the sample exhibiting the greatest VOC concentrations based on the field analysis being submitted for laboratory analysis. Field Screening will be performed using Strategic Diagnostics, INC. (SDI) Quicktest™ field test kits. Documentation and procedures for this kit are included in Appendix C. If the field screening results for all samples within one monitoring well screened interval are below the method detection limits, the sample collected from the PDBS positioned closest to the saturated screen midpoint will be sent to the laboratory for analysis.

3.1.3 Analytical Results Comparison/Evaluation

Analytical results for groundwater samples collected using the PDBSs and using conventional techniques will be compared, and the results will be evaluated. Typically, if maximum concentrations from the PDBS are higher than concentrations in samples collected using the conventional method, it is probable that the concentrations from the PDBS are more representative of ambient groundwater chemistry conditions than are the conventional-sampling data (Vroblesky, 2001). If, however, the conventional method produces VOC results that are higher by a predetermined amount than the concentrations reported for the PDBS, then the PDBS may not adequately represent local ambient groundwater conditions. In this case, the difference may be due to a variety of factors, including hydraulic and chemical heterogeneity within the saturated screened interval of the well, vertical flow of groundwater within the well, and/or the relative permeability of the well screen with respect to the surrounding aquifer matrix (Vroblesky and Campbell, 2000).

Considering the above guidance, if the maximum analytical result obtained using the PDBS is greater than or equal to the conventional sampling result, it will indicate that the PDBS method is appropriate for use in that particular well and no further comparison of results will be performed. However, if the maximum PDBS result is less than the conventional sampling result, further comparison of the two sets of results will be undertaken. In this instance, analytical results for samples collected using the diffusion samplers will be compared to results from the conventional sampling using relative-percent-difference (RPD), as defined by the following equation:

$$RPD = 100*[abs(D-C)]/[(D+C)/2]$$

Where:

abs = absolute value

D = diffusion sampler result

C = conventional sample result.

For this investigation, an RPD of less than 15 will be considered to demonstrate good correlation between sample results. Calculated RPDs in excess of 15 will be reviewed individually in an attempt to determine the reason for the variance.

3.1.4 Waste Management

Investigation derived waste (IDW) produced as part of this program will consist of purge water, decontamination solvents, and personnel protective equipment (PPE). All purge water and decontamination solvents will be containerized in Department of Transportation (DOT) approved 55 gallon drums and stored onsite temporarily in an area designated by current site contractor. After sampling activities associated with this project are complete the liquid wastes will be completely characterized through laboratory analysis. Following characterization the IDW will be disposed of appropriately depending on the results of the waste characterization analyses.

3.2 Monitoring Network Optimization Evaluation

A portion of the groundwater monitoring network at this installation will be evaluated using both qualitative assessments and a geographical information system (GIS)-based algorithm that performs statistically based temporal and spatial analyses of monitoring-well information. Locations and completion intervals of individual monitoring wells and sampling points will be examined, and the informational contribution of each well or sampling point to the network will be weighed against the cost of monitoring at that point. Monitoring protocols and analytical methods also will be evaluated. Where warranted, recommendations will be developed for optimization of the portion of the monitoring network that is evaluated. Methods to be used in the evaluation will include, but are not limited to, qualitative hydrogeologic and hydrochemical analyses, application of statistical optimization techniques, and application of decision-logic structures.

A maximum of 30 monitoring wells at this installation will be evaluated as part of this task. Parsons ES will coordinate with Buckley AFB to determine which wells to include in the evaluation. The results of the evaluation will be included in the Site-Specific Diffusion Sampler Demonstration Report for Buckley Air Force Base.

4.0 PROJECT ORGANIZATION

Addresses and telephone numbers of the TO management team are as follows:

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Lab Contact: Monika	O'Brien and Gere		(315) 437-0200 email:	

5.0 SCHEDULE

Work performed as part of this demonstration at Buckley AFB will be completed according to the schedule summarized below.

- Submittal of the Draft Buckley AFB PDBS Work Plan to commenting parties: July 18, 2001
- Receipt of Draft Buckley AFB PDBS Work Plan Comments: July 27, 2001
- Submittal of the Final Buckley AFB PDBS Work Plan to commenting parties: August 3, 2001
- Install PDBS samplers in 16 monitoring wells at Buckley AFB: July 30-31, 2001
- Remove PDBS samplers from 16 monitoring wells at Buckley AFB: August 13-14, 2001
- Conventional groundwater sampling of 12 wells: August 13-17, 2001
- Preparation of the Draft Buckley AFB PDBS Report: September 17 - November 19, 2001.

6.0 REPORTING

The site specific results report will provide a scaled map and accompanying table identifying the location and depth for each PDBS sample collected. Analytical results collected as part of this study will be compared to analytical results collected by URS and Parsons ES using conventional sampling methods in a scientifically defensible manner using statistical analyses. The results of the statistical comparisons will be presented in a clear and logical manner in the results report. Statistical methods will include calculation of RPDs between PDBS and conventional sampling results, and possibly parametric or non-parametric analysis of variance (ANOVA) tests. The draft version of this report will be distributed according to the schedule shown in Table 6.1 of the AFILEV PDBS Project Work Plan (Parsons, 2001). Each site-specific report also will be included as an appendix to the Final Comprehensive PDBS Report for AFILEV sites.

7.0 REFERENCES

ERM, 1999a. *Installation Restoration Program (IRP) Final Groundwater Monitoring Report for the Former Warehouse Area, Buckley Air Force Base, Aurora, Colorado*. Prepared for Air National Guard Installation Restoration Program, Andrews AFB, Maryland. June.

ERM, 1999b. Installation Restoration Program Final Remedial Investigation Report for the Former Warehouse Area, *Buckley Air Force Base, Aurora, Colorado*. Prepared for Air National Guard Installation Restoration Program, Andrews AFB, Maryland. October.

ERM, 2001a. *Final Technical Memorandum, Additional Plume Characterization and Groundwater Monitoring for the Former Warehouse Area, Buckley Air Force Base, Aurora, Colorado*. Prepared for Air National Guard Installation Restoration Program, Andrews AFB, Maryland. February.

ERM, 2001b. Conventional sampling SAP/QAPP

Parsons. 2001. *Work Plan for the Air Force Environmental Directorate Passive Diffusion Sampler Demonstration.* April.

Stone & Webster Environmental Technology and Services,1997. *Former Warehouse Area Site Investigation Report, Volume I*. Prepared for Departments of the Army and the Air Force National Guard Bureau. July1997.

Vroblesky, Don A., 2001. User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells. US Geological Survey Water-Resources Investigations Report 01-4060. Columbia, South Carolina.

ADDENDUM TO THE PROGRAM HEALTH AND SAFETY PLAN
FOR THE EVALUATION OF
PASSIVE DIFFUSION BAG SAMPLERS (PDBS)

AT

BUCKLEY AIR FORCE BASE
DENVER, COLORADO

July 2001

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290

Reviewed and Approved By:

	Name	Date
Project Manager	______________________	____________
Office Health and Safety Representative	______________________	____________

1.0 INTRODUCTION

This addendum modifies the existing program health and safety plan entitled *Program Health and Safety Plan for the Evaluation of Passive Diffusion Bag Samplers (PDBSs)* (Parsons Engineering Science, Inc., [Parsons] 2001) for the evaluation of the use of PDBSs in existing groundwater monitoring programs at selected Department of Defense installations across the United States. This work is being performed under contract number F41624-00-D-8024 Task Order 0024, Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base.

This addendum to the program health and safety plan was prepared to address the upcoming tasks at Buckley Air Force Base (AFB) in Colorado. Included or referenced in this addendum are the scope of services, site specific description and history, project team organization, hazard evaluation of physical hazards and of known or suspected chemicals, and emergency response information. All other applicable portions of the program health and safety plan remain in effect.

2.0 SCOPE OF SERVICES

Site activities will involve the placement of a water-filled diffusive membrane capsule in a well installation device at a specific depth in an existing groundwater monitoring well. The wells are located in various areas throughout the base. After a specified period of time, the water in the sampler is transferred to a sample container and submitted for laboratory analysis. No drilling or ground-intrusive activities are anticipated under the current scope of work.

3.0 SITE SPECIFIC DESCRIPTION HISTORY

The descriptions, history, and maps for the various sites are contained in the work plan entitled *Site-Specific Work Plan for the Air Force Environmental Directorate Passive Diffusion Bag Sampler Demonstration at Buckley AFB* (Parsons, 2001).

4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the PDBS demonstration activities at Buckley AFB is identified in the program health and safety plan. The following personnel will also be involved in this project.

Ms. Linda Murray	Project Manager
Mr. John Hicks	Task Manager
Ms. Marty Reimann	Site Manager
Mr. John Tunks	Site Health and Safety Officer
Mr. Mark Ashton	Buckley AFB Site Contact

5.0 HAZARD EVALUATION

5.1 Chemical Hazards

The primary contaminants of concern at the various sites are chlorinated solvents and the volatile hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). Health hazard qualities for these and other compounds are presented in Table 5.1 at the end of this addendum. If other contaminants are found to exist at the site, this addendum will be modified to include the necessary information that will then be communicated to the onsite personnel.

5.2 Physical Hazards

Potential physical hazards at Buckley AFB include hazards associated motor vehicles; slip, trip, and fall hazards; noise; and heat exposure. These hazards are discussed in the program health and safety plan.

6.0 EMERGENCY RESPONSE PLAN

6.1 Emergency Contacts

In the event of any emergency situation or unplanned occurrence requiring assistance, the appropriate contacts should be made from the list below. A list of emergency contacts must be posted at the site.

Contingency Contacts	**Telephone Number**
Site/Medical Emergency	911
Buckley AFB Fire Department	911 or (303) 677-9929
Buckley AFB Security	911 or (303) 677-9930
Site Contact: Mark Ashton	(719) 554-3653

Medical Emergency

Hospital Name	Medical Center of Aurora
Address	700 Potomac Street, Aurora, CO 80011
Telephone Number	911 or (303) 363-7200
Ambulance	911

Directions to the Base Hospital:

Exit Buckley AFB at 6th Avenue and turn left (west) onto 6th Avenue. Proceed past Interstate 225 to Potomac Street. Turn right (north) onto Potomac Street. The hospital will be on the right (east) side of the street.

Parsons ES Contacts	Telephone Number
Linda Murray Project Manager	(303) 831-8100 or 764-1904 (Work) (303) 279-9129 (Home)
John Hicks Task Manager	(303) 831-8100 or 764-1941 (Work) (303) 279-3698 (Home)
Tim Mustard, CIH Program Health and Safety Manager	(303) 831-8100 or 764-8810 (Work) (303) 450-9778 (Home)
Ed Grunwald, CIH Corporate Health and Safety Manager	(678) 969-2394 (Work) (404) 299-9970 (Home)
Judy Blakemore Assistant Program Health and Safety Manager	(303) 831-8100 or 764-8861 (Work) (303) 828-4028 (Home) (303) 817-9743 (Mobile)

7.0 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

The personal protection level prescribed for field activities at Buckley AFB is Occupational Safety and Health Administration (OSHA) Level D with a contingency for the use of OSHA Level C or B, as site conditions require. The flow chart presented in Figure 7.1 of the program health and safety plan and this addendum will be used to select respiratory protection with the following comments and additions.

Since there is no Dräger® tube for 1,2-DCA, the following will occur. If sustained air monitoring readings in the worker breathing zone indicate vapor concentrations greater than or equal to 1 part per million (ppm) above background for 30 seconds or longer, the field crew will be forced to evacuate and ventilate the area until readings are less than 1 ppm in the worker breathing zone. If ventilation is inadequate, air samples will be taken to confirm or deny the existence of the contaminants of concern and/or the crew will upgrade to Level B respiratory protection. These air samples will be sent to a lab to be analyzed by US Environmental Protection Agency (USEPA) Compendium Method TO-14 or the equivalent. Method TO-14 will also analyze for the other volatile contaminants of concern at the site as listed in Table 5.1 of this addendum.

If 1,2-DCA is found to exist in the worker-breathing zone at concentrations above 1 ppm above background, additional work must be performed in OSHA Level B personal protective equipment (PPE) due to the inadequate warning properties of the compound.

If 1,2-DCA does not exist, a reading of 2 ppm above background in the worker-breathing zone will require the use of Dräger® tubes or the equivalent to determine if carbon tetrachloride and/or chloroform are/is present. Level B protection must also be used if concentrations of carbon tetrachloride and/or chloroform meet or exceed 2 ppm above background in the worker-breathing zone.

If the above compounds are not present, and field activities will continue with Level D protection, a reading of 5 parts per million (ppm) above background in the worker breathing zone will require the use of a Dräger® tube or the equivalent to determine if benzene is present at a concentration greater than or equal to the PEL of 1 ppm. The flow chart presented in Figure 7.1 and appropriate text in the Program Health and Safety Plan (HASP) then will be used to select respiratory protection against volatile hydrocarbon constituents.

If sustained air-monitoring readings in the worker-breathing zone persist at or above 25 ppm, Dräger® tubes or the equivalent must be used to confirm or deny the presence of tetrachloroethene (PCE) and/or methylene chloride. Due to the inadequate warning properties of PCE and methylene chloride, Level B protection must be used if concentrations of PCE and/or methylene chloride meet or exceed 25 ppm above background in the worker-breathing zone.

If PCE and/or methylene chloride are/is not present, continue to monitor the air in the worker-breathing zone. If concentrations in the worker-breathing zone persist above 25 ppm above background, periodic use of the PCE and/or methylene chloride Dräger® tubes must be used to confirm the absence of the compounds.

If the PID indicates concentrations at or above 50 ppm above background in the worker-breathing zone, the screening process must be repeated with trichloroethene (TCE) Dräger® tubes to confirm or deny the presence of TCE.

Section 7 of the Program HASP contains guidelines for selection of PPE. PPE will be required when handling contaminated samples and when working with potentially contaminated materials. See Page 7-4 of the HASP for PPE to be used.

8.0 FREQUENCY AND TYPES OF AIR MONITORING

A photoionization detector (PID) with an 11.7 electron volts (eV) (HNU®) or equivalent lamp will be used for air monitoring during this project since the ionization potentials of the contaminants of concern are below 11.7 eV.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	0.5 (skin) [g/]	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
Bromodichloromethane	NA [h/]	NA	NA	1,680 mg/m^3 [i/]	10.88	Nonflammable liquid. Carcinogen.
Bromoform	0.5 (skin)	0.5 (skin)	850	530	10.48	Colorless to yellow liquid (solid<47°F) with a chloroform-like odor. Irritates eyes, skin, and respiratory system. Causes CNS depression and liver and kidney damage. Mutagen.
Carbon Tetrachloride	2	5 (skin)	200	21.4-200	11.47	Colorless liquid with characteristic, ether-like odor. Irritates eyes and skin. Causes CNS depression, nausea, vomiting, liver/kidney damage, drowsiness, dizziness, and incoordination. In animals, causes liver cancer. Mutagen, experimental teratogen, and carcinogen.
Chloroform (Trichloromethane)	2	10	500	205 [j/]	11.42	Colorless, heavy liquid with pleasant odor. Irritates eyes and skin. Anaesthetic. Causes dizziness, mental dullness, nausea, confusion, headache, fatigue, anesthesia, and enlarged liver. Also attacks kidneys and heart. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
Dibromochloromethane (Chlorodibromomethane)	NA	NA	NA	NA	10.59	Colorless to pale-yellow, heavy liquid. Skin, eye irritant. Narcotic. Mutagen.
1,2-Dichloroethane (DCA) (Ethylene Dichloride, EDC)	1	10	50	100	11.05	Colorless liquid with a pleasant, chloroform-like odor. Strong narcotic. Irritates eyes. Causes corneal opaqueness, nausea, CNS depression, vomiting, dermatitis, and damage to liver, kidneys, and cardiovascular system. In animals, causes cancer of the forestomach, mammary gland, and circulatory system. Mutagen, experimental teratogen, and carcinogen.
1,2-Dichloroethene (DCE) (cis- and trans-isomers)	200	200	1,000	0.085-500	9.65	Colorless liquid (usually a mixture of cis- and trans- isomers), with a slightly acrid, chloroform-like odor. Irritates eyes and respiratory system. CNS depressant. Cis- isomer is a mutagen.
Ethylbenzene	100	100	800 (10% LEL) [k/]	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Bis(2-Ethylhexyl)Phthalate (Di-sec Octyl Phthalate)	5 mg/m^3	5 mg/m^3	5,000 mg/m^3	NA	NA	Colorless to light-colored, oily liquid with slight odor. Irritates eyes and mucous membranes. Also affects respiratory system, CNS, and gastrointestinal tract. In animals, causes liver damage, liver tumors,

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms
						and teratogenic effects. Carcinogen.
Methylene Chloride (Dichloromethane, Methylene Dichloride)	25	50	2,300	25-320	11.32	Colorless liquid (gas>104°F) with a sweet, chloroform-like odor (not noticeable at dangerous concentrations). Irritates eyes and skin. Causes nausea, vomiting, fatigue, weakness, unnatural drowsiness, light-headedness, numbness, tingling limbs, and nausea. In animals, causes lung, liver, salivary and mammary gland tumors. Mutagen, experimental teratogen, and carcinogen.
Perchlorethylene (Tetrachloroethene or PCE)	25 [l/]	25	150	5-50	9.32	Colorless liquid with a mild chloroform odor. Eye, nose, skin and throat irritant. Causes nausea, flushed face and neck, vertigo, dizziness, headaches, hallucinations, incoordination, drowsiness, coma, pulmonary changes, and skin redness. Cumulative liver, kidney, and CNS damage. In animals, causes liver tumors. Mutagen, experimental teratogen, and carcinogen.
Toluene	100	50 (skin)	500	0.2-40 [j/]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
Trichloroethene (TCE)	50	50	1,000	21.4-400	9.45	Clear, colorless or blue liquid with chloroform-like odor. Irritates skin and eyes. Causes fatigue, giddiness, headaches, vertigo, visual disturbances, tremors, nausea, vomiting, drowsiness, dermatitis, skin tingling, cardiac arrhythmia, and liver injury. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 [j/]	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain, and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1997. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), *TVLs® and BEIs®* (2001).

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms

effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards* , 1997.

d/ When a range is given, use the highest concentration.

e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards* , June 1997.

f/ Refer to expanded rules for this compound.

g/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.

h/ NA = Not available.

i/ mg/m^3 = milligrams per cubic meter.

j/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.

k/ Indicates that the IDLH value was based on 10% of the lower explosive limit for safety considerations, even though relevant toxicological data indicated that irreversible health effects or impairment of escape existed only at higher concentrations *(NIOSH Pocket Guide to Chemical Hazards, 1997).*

l/ NIOSH recommends reducing exposure to the lowest feasible concentration, and limiting the number of workers exposed.